## Remarks

The above Amendments and these Remarks are in reply to the Office Action mailed July 23, 2004. Claims 1, 3-15 and 18-67 were pending in the Application prior to the outstanding Office Action. In the Office Action, the Examiner rejected claims 1, 3-15, 18-40, 43-45, 47-49, 51-53, 55-57 and 59-67. The rest of the outstanding claims are subject to restriction requirement. The present Response withdraws claims 41, 42, 46, 50, 54 and 58, amends claims 1, 8-12, 18, 21, 22, 25-29, 32-36, 38, 40, 43, 60-67, leaving for the Examiner's present consideration claims 1, 3-15, 18-40, 43-45, 47-49, 51-53, 55-57, 59-67. Reconsideration of the rejections is respectfully requested.

### I. Restriction and/or Election

Claims 41, 42, 46, 50, 54 and 58 are subject to restriction and/or election requirement.

Applicant hereby withdraws claims 41, 42, 46, 50, 54 and 58 without prejudice being drawn to non-elected inventions and without disclaimer of the subject matter disclosed therein. Applicant reserves the right to prosecute the non-elected claims in a future continuing, or divisional application.

### II. Claim Rejections - 35 USC § 102

1. Claims 1, 2, 7, 9-11, 18-20 and 22-39, 44, 45, 48, 49, 56 and 57 are rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent 4,035,604 issued to *Meleka et al.* (hereinafter, *Meleka*).

The reactive atom plasma processing (RAPP) in independent claims 1, 22-31, 33-36 and 38 is mainly used for shaping a surface and is distinguishable from *Meleka*, an inductively coupled plasma (ICP) mainly used for de-burring, in the following important aspects:

- RAPP is a deterministic, controlled process, capable of relying on the stability of the discharge and careful control of the distribution and concentration of reactive material in the plasma to make predictable corrections to a surface and improve/smooth it to a pre-determined shape. It would remove a burr and its surrounding material at nearly the same rate. In contrast, *Meleka* is not deterministic and does not alter the basic shape of workpiece, so it cannot be used for precision shaping. It is specifically designed to remove burrs and only burrs (column 1, lines 43-44, claim 1), no attempt is made to spatially control the material removal process. *Meleka* is

selective with respect to localized removal of a burr or similar high-aspect ratio asperity (column 2, lines 3-6) created during metal forming, but it does not remove material around the burr under similar configurations. In other words, the shape of the burr and the conductivity of the material determine how the material is to be removed, and the burr must be sharper than the part of the workpiece that is to remain un-etched. This is because *Meleka* relies on the concentration of the electric field around the burrs to raise the temperature of the burr (column 5, lines 23-26) whereas no such concentration or localized temperature increase occurs with RAPP. Since a burr is a singular feature, its presence is not the equivalent of "roughness" across an entire surface, and thus its removal is not the same as shaping of a surface. In fact, *Meleka* makes no such claim.

- RAPP produces a downstream plasma that removes material everywhere that the plasma impinges on the surface. The plasma is not required to directly interact with the workpiece; its function is to produce reactive species that are then transported to the surface of the workpiece. An injected species (precursor) is broken down by the plasma into neutral reactive atomic radicals that react across the entire surface and produces a gaseous compound that leaves the surface as a gas. Furthermore, no thermal concentration is either observed or required. In contrast, *Meleka* requires differential heating of the burr relative to the surrounding material and the electrostatic field is concentrated at this burr (column 5, lines 28-35). Oxygen is added to create an "exothermic reaction with the hot burrs", which also generates an oxide on the surface of the burr and the oxide must be removed either by the blowing action of the plasma discharge or by brushing off the oxide AFTER processing (column 5, lines 45-50, see also column 6, lines 59-63). There is no specific chemical reaction that produces a gas phase product and the device will be totally non-functional if moved to a non-contact position. The material to be removed either melts, allowing surface tension to redistribute the metal; or, the burr vaporizes from the extreme heat, later reacting with the air, re-depositing on the first available surface. More importantly, the shape and stability of the discharge and the distribution of the reactive material in the discharge have no significant or important influence on the process.
- The shaping in RAPP is "damage-free" since it applies no physical force on the surface, and any subsurface damage that is present in brittle materials in the form of cracks, dislocations and defects are not further propagated into the material, which can be either electrically conducting or

non-conducting. In contrast, the damage referred to in *Meleka* is exclusively due to arcing from the plasma to the burr to be removed (column 2, lines 25-30). Such arcing damage only happens on electrically conducting materials, and could not occur under RAPP process since the small voltage between the plasma discharge and the workpiece prevents the build-up of an electrical potential that could break down into an arc.

- RAPP works with both electrically insulated and conductive materials, while *Meleka* works for conductive materials only (column 1, line 47, see also column 10, lines 11-12). This is due to the inability of *Meleka* to create a chemical reaction, thus only materials, such as metal, with a melting point that can be reached by exposure to the discharge will respond. Important materials such as optic, silicon carbide, and a number of nitrides and carbides that can be shaped by RAPP however, will not respond to the *Meleka*.

Therefore, *Meleka* cannot anticipate independent claims 1, 22-31, 33-36 and 38. Since claims 7, 9-11, 18-20, and 32 depend on claim 1, claims 44, 48, 56 depend on claim 36, and claims 39, 45, 49, and 57 depend on claim 38, *Meleka* cannot anticipate claims 1, 7, 9-11, 18-20 and 22-39, 44, 45, 48, 49, 56 and 57 (claim 2 was previously canceled), and Applicant respectfully requests that the rejection with respect to these claims be withdrawn.

2. Claims 1, 3-11, 13, 15, 18, 22-27, 30-40, 43-45, 47-49, 51-53, 55-57 and 59-67 are rejected under 35 U.S.C. § 102(a) as being anticipated by *Böhm et al.* in DE 199 25 790 Al (hereinafter, *Böhm*).

Although *Böhm* addresses the same manufacturing need as the reactive atom plasma processing (RAPP) in independent claims 1, 22-27, 30-31, 33-36, 38, 40, 43, and 60-67, it is distinguishable from RAPP in the following important aspects:

- The shape of the plasma discharge. *Böhm* uses microwave energy at the end of a microwave guide to create the discharge along the central axis. At such frequency, the discharge is roughly spherical in shape with density decreasing with distance from the center and 1-3 mm in optimum diameter size at atmospheric pressure. Such a discharge is subject to contamination through electrode sputtered material that acts as a mask on the surface of the workpiece, preventing uniform etching and creating defects. In contrast, RAPP creates a doughnut-like plasma that is symmetric with respect to the central axis but with a low density zone along the axis. The

discharge is typically 20 to 25 mm in diameter. The plasma can be annular (claim 1, 22, 23-25, 30-31, 33, 36, 60, 62, 64, 66) or toroidal (claim 27) in shape, and has a skin (claim 26), internal zone (claim 34-35) or center (claim 38,40,43,61,63,65,67). Such geometry is advantageous for the introduction of a precursor and, along with the excitation mechanism, it can act as a barrier to prevent the reactive species from interacting with the atmosphere.

- The function of the torch. Although a three tube torch design is coincidentally used in both *Böhm* and RAPP, it functions in totally different ways. *Böhm* uses the torch as a microwave antenna to create the plasma discharge (in the field of the antenna) and to determine its shape, wherein the outer tube must be conductive and acts like an outer conductor in a coaxial cable, the space between the outer and intermediate tube serves as a dielectric, and the intermediate tube would act as the central electrode. In contrast, the torch in RAPP is primarily used as an insulator to control the flow of gases while the electromagnetic field is generated by a cylindrical load coil. The flow of gas determined by the torch geometry has a strong effect on the stability of the plasma discharge, which is physically inside the load coil.
- The way the discharge creates the reactive species. *Böhm* uses the electromagnetic (EM) field radiated by a microwave antenna to create the reactive species directly from the precursor. In contrast, RAPP utilizes the energy of the radio frequency (RF) power source to create and sustain a plasma discharge in an inert gas (e.g. Argon). The RF energy is transferred to the precursor that subsequently fragments into the reactive species primarily through collisions between the electrons and Argon ions and the precursor. Compared to *Böhm*, such transfer can take place well out of the range of the EM field developed by the RF source. And it can excite a wider range of precursors due to its thermal nature. In addition, the efficiency of energy transfer is greater and more consistent.

Therefore, *Böhm* cannot anticipate independent claims 1, 22-27, 30-31, 33-36, 38, 40, 43, and 60-67. Since claims 3-11, 13, 15, 18, 32 depend on claim 1, claims 37, 44, 48, 52, 56 depend on claim 36, claims 39, 45, 49, 53, 57 depend on claim 38, and claims 47, 51,55, 59 depend on claim 43, *Böhm* cannot anticipate claims 1, 3-11, 13, 15, 18, 22-27, 30-40, 43-45, 47-49, 51-53, 55-57 and 59-67, and Applicant respectfully requests that the rejection with respect to these claims be withdrawn.

## III. Claim Rejections - 35 USC § 103

1. Claims 19-21, 28 and 29 are rejected under 35 U.S.C. § 103(a) as being unpatentable over *Böhm*.

As discussed in previous section, independent claims 1, 21, 28 and 29 cannot be anticipated by *Böhm*. Since claims 19 and 20 depend on claim 1, claims 19-21, 28 and 29 cannot be anticipated by *Böhm*, and Applicant respectfully requests that the rejection with respect to these claims be withdrawn.

2. Claim 12 is rejected under 35 U.S.C. § 103(a) as being unpatentable over *Böhm* as applied to claim 1 above, and further in view of *Zarowin et al.* in Rapid Non-Contact, Damage Free Shaping of Optical and Other Surfaces with Plasma Assisted Chemical Etching, 43rd Annual Symposium on Frequency Control 1989, 632-626 (hereinafter, *Zarowin*).

*Zarowin* teaches a plasma shaping method (PACE) that does not create a (annular) plasma nor inject a species into it to produce reactive species, so it cannot anticipate the RAPP in claim 1. Since neither *Böhm* nor *Zarowin* can anticipate the RAPP in claim 1, and claim 12 depends on claim 1, claim 12 cannot be rendered obvious under 35 U.S.C. § 103(a), and Applicant respectfully requests that the rejection with respect to claim 12 be withdrawn.

3. Claim 14 is rejected under 35 U.S.C. § 103(a) as being unpatentable over *Böhm* as applied to claim 13 above and further in view of US Patent 6,068,784 issued to *Collins*.

*Collins* teaches a plasma chamber using RF energy, it does not teach creating a (annular) plasma and injecting a species into it to produce reactive species either, so it cannot anticipate the RAPP in claim 1. Since neither *Böhm* nor *Collins* can anticipate the RAPP claim 1, and claim 14 depends on claim 1, claim 14 cannot be rendered obvious under 35 U.S.C. § 103(a), and Applicant respectfully requests that the rejection with respect to claim 14 be withdrawn.

## IV. Conclusion

In light of the above, it is respectfully submitted that all of the claims now pending in the subject patent application should be allowable, and a Notice of Allowance is requested. The

Examiner is respectfully requested to telephone the undersigned if he can assist in any way in expediting issuance of a patent.

The Commissioner is authorized to charge any underpayment or credit any overpayment to Deposit Account No. 06-1325 for any matter in connection with this response, including any fee for extension of time, which may be required.

Respectfully submitted,

Date: 10/25/04

By: _____

Tianxiong Xue
Reg. No. 54,554

FLIESLER MEYER LLP
Four Embarcadero Center, Fourth Floor
San Francisco, California 94111-4156
Telephone: (415) 362-3800
Fax: (415) 362-2928
Customer No.: 23910